A DIMM AND METHOD FOR PRODUCING A DIMM

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CROSS REFERENCES TO RELATED APPLICATION

This is application is related to co-pending application having Application No. 10/XXX,XXX (attorney docket no. 100203777-1), by inventors Derek Schumacher and Vince Leung, filed July 10, 2002, and entitled "A METHOD FOR CHANGING COMPUTER SYSTEM MEMORY DENSITY", which is hereby fully incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

Embodiments of the present invention relate generally to computer systems. More particularly, embodiments of the present invention provide a reduced-memory capacity device and methods for producing a device having a reduced memory capacity. More particularly further, embodiments of the present invention provide a Dual Inline Memory Module (DIMM) and a method for furnishing and/or using a DIMM with a reduced memory capacity.

2. Description of the Background Art

DIMMs of different memory capacities are used in various devices, such as computers and servers. The memory capacity of a DIMM used in any particular device depends on the desired capabilities of the device. When a DIMM is in need of replacement, it is typically replaced with a DIMM of equal memory capacity as the cost of a DIMM increases with memory capacity. Thus,

suppliers of DIMMs have to maintain a sufficient inventory of DIMMs of diverse memory capacities (i.e., multiple DIMM densities), because any particular product, such as a computer or server, requires support for the following DIMM densities: 256MB, 512MB, and 1 GB.

As technology continually improves, fewer and fewer devices or products are produced where a small memory capacity DIMM is employed. Assurance of supply of DRAMs used to produce smaller DIMM densities is becoming increasingly difficult and the current price/Mb for a DRAM density Mb of 128Mb is approximately the same as, or is approaching that of, a DRAM density Mb of 64Mb which is trailing edge DRAM technology. Therefore, suppliers are now faced with the problem of having to maintain inventory of essentially obsolete trailing edge DRAM technology in order to support the users of devices or products employing reduced-memory DIMM densities, such as devices or products with long lifespans (e.g., servers). Stated alternatively, suppliers currently have to continue to support multiple DIMM densities by having to procure and qualify end-of-life material (e.g., trailing edge DRAM technology). Thus, manufacturing processes remain complex because of the current use of different DRAM parts for multiple DIMM assemblies.

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SUMMARY OF EMBODIMENTS OF THE INVENTION

Embodiments of the present invention provide a method for producing a device (e.g., a module) having a reduced memory capacity. The method includes determining that the memory capacity of the device can be reduced, determining an amount by which the memory capacity of the device is to be reduced, and reducing the memory capacity of the device in accordance with the determined amount to produce a device having a reduced memory capacity and a dormant memory capacity. The method may additionally include determining an available memory capacity of another device (e.g., a second module) in an apparatus (e.g., a computer) which requires the other device to have the available memory capacity. The difference between the memory capacity of the device and the memory capacity of the other device may approximate the dormant memory capacity. The method may further additionally comprise furnishing the apparatus with the device having the reduced memory capacity and the dormant memory capacity.

Embodiments of the present invention also provide a method for producing a DIMM having a reduced memory capacity comprising providing a DIMM having a memory capacity, determining that the memory capacity of the DIMM can be reduced, determining an amount by which the memory capacity of the DIMM is to be reduced, and reducing the memory capacity of the DIMM in accordance with the determined amount to produce a DIMM having a reduced memory capacity which is available for use and a dormant memory capacity which is not available for use. The method may further additionally comprise determining the total available memory capacity of another DIMM in an apparatus, such as a computer, which requires the other DIMM to have the available memory capacity. The available memory capacity of the other DIMM is less than the memory capacity of the DIMM, typically less than by multiples of an order of two(2). The method may further additionally comprise furnishing the apparatus with the DIMM having the reduced memory capacity which is available for use and the dormant memory capacity which is not available for use. The difference between the memory capacity of the DIMM and the memory capacity of the second DIMM comprises a dormant memory capacity. Reducing the memory capacity of the DIMM comprises disposing the DIMM in an EEPROM assembly, programming the EEPROM with a program which includes row, bank and column

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information, and executing the program in order to reduce the memory capacity of the DIMM. The method may also further additionally comprise replacing a DIMM in a apparatus, such as a computer, with a DIMM having a reduced memory capacity and a dormant memory capacity.

Additional embodiments of the present invention provide an assembly (e.g., a computer assembly) comprising an apparatus (e.g., a computer), and a device (e.g., a module or a DIMM) disposed in the apparatus and having a reduced memory capacity which is available for use and a dormant memory capacity which is not available for use. The device may be produced in accordance with any of the methods for embodiments of the present invention.

These provisions together with the various ancillary provisions and features which will become apparent to those artisans possessing skill in the art as the following description proceeds are attained by devices, assemblies, systems and methods of embodiments of the present invention, various embodiments thereof being shown with reference to the accompanying drawings, by way of example only, wherein:

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is schematic block-flow diagram illustrating an embodiment for producing or furnishing a DIMM having a reduced memory capacity.

Figure 2 is a perspective view of an EEPROM programming assembly.

Figure 3 is a schematic partial top plan view of a DIMM before reducing memory capacity.

Figure 4 is a schematic partial top plan view of the DIMM of Figure 3 after reducing its memory capacity, more specifically at least one row and/or column of a bank.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

In the description herein, numerous specific details are provided, such as examples of components and/or methods, to provide a thorough understanding of embodiments of the present invention. One skilled in the relevant art will recognize, however, that an embodiment of the invention can be practiced without one or more of the specific details, or with other apparatus, systems, assemblies, methods, components, materials, parts, and/or the like. In other instances, well-known structures, materials, or operations are not specifically shown or described in detail to avoid obscuring aspects of embodiments of the present invention.

A "computer" for purposes of embodiments of the present invention may be any processor-containing device, such as a mainframe computer, a personal computer, a laptop, a notebook, a microcomputer, a server, or any of the like. "EEPROM" means an electrically erasable programmable read-only memory.

Referring now to Figure 1 there is seen a schematic block-flow diagram of a process, generally illustrated as

10, for reducing the memory capacity of a device, such as a module or a DIMM. It is to be understood that while the illustration and description of the memory-reduction process will use a DIMM, the spirit and scope of embodiments of the present invention would include any device having a memory capacity for which a reduction may be desired.

The process includes, as represented by block **14,** obtaining a DIMM having a memory capacity (e.g., 512MB). Subsequently, a determination is made as to whether or not the memory capacity of the DIMM needs to be or is capable of being reduced, as represented by block **18** in Figure 1. Thus, by way of example only, if a computer DIMM with a memory capacity of 256MB is to be replaced, it would be replaced with a computer DIMM having the same memory capacity of 256MB, and not with a computer DIMM having a memory capacity of 128MB or 64MB. Therefore, the DIMM whose memory capacity is to reduce would have a memory capacity greater than 256MB. Otherwise, no memory reduction would be required and the process would terminate as represented by circle **20.**

After a determination has been made as to whether or not the memory capacity of the DIMM needs to be or can be reduced, a determination is then made as to the amount of

reduction in memory capacity which is to be conducted, as represented by block **22**. Thus, if a computer DIMM with a memory capacity of 128MB is to be replaced, and the DIMM whose memory capacity is to be reduced has a memory capacity of 512MB, the amount of required reduction in the memory capacity of the DIMM would be 384MB, or the reduction would be by a factor of four(4); that is, 512MB divided by four(4) equals the reduced memory capacity of 128MB. The reduction factor would be some power (e.g., the first power, the second power, the third power, etc.) of the integer two(2).

After a determination has been made as to the amount (i.e., the reduction factor or by what power of 2) of reduction in memory capacity is desired or needed, the desired memory capacity reduction is subsequently conducted or performed on the DIMM. The memory capacity of the DIMM may be reduced by any suitable means, or with any suitable assembly, such as the EEPROM assembly **40** of Figure 2 and in accordance with the instructions of block **26** in Figure 1.

The EEPROM assembly **40** includes a workstation **44** and a DIMM fixture **48**. The DIMM, whose memory capacity is to be reduced, is installed into the DIMM fixture **48**. Subsequently, reduced memory capacity information for the

DIMM is entered into the workstation **44**. This information would include row, column, and bank information which is to be programmed into the EEPROM and represents and/or corresponds to the desired reduced memory capacity. After the reduction-in-memory program has been entered into the workstation **44**, the row, column and bank information (i.e., reduction in memory capacity information) of the program entered into the workstation **44** will be transferred to the DIMM for erasing the desired memory capacity of the DIMM. By way of example only and referencing now Figure 3, there is seen a top plan view of a memory address or capacity for a DIMM, including Bank 0 and Bank 1 with each bank having 4 columns and 4 rows. After the memory capacity of the DIMM has been reduced (e.g., by one-half) by the EEPROM assembly **40** of Figure 2, part of the original memory of the DIMM has been made unusable and is dormant. As illustrated in Figure 4, all of the original memory (i.e., the memory of Bank 0 and Bank 1) of the DIMM is still there, but only half (i.e., Bank 0) is usable or addressable. The memory capacity of Bank 1 has been inactivated. Thus, the reduced memory capacity DIMM may now be used in a computer that requires only the memory capabilities possessed by bank 0, because the computer would not be able to use any memory capabilities originally possessed by Bank 1.

It is to be understood that while an entire bank has been made unusable and/or dormant, the spirit and scope of the present invention includes making at lest part of a bank unusable and/or dormant. Thus, at least one row and/or at least one column of one or more banks may be made unusable and/or dormant. Therefore, with respect to Figure 3, instead of four columns and four rows of Bank 1 being unusable and/or dormant, one or more rows and/or one or more columns may be selectively made dormant and/or unaddressable.

Before the reduced memory DIMM is used, it should be tested in accordance with block **30** of Figure 1 for memory-reduction accuracy to ensure that desired amount of memory was accurately reduced or removed from the DIMM and that the required amount of memory is available on the DIMM. Testing may be by any suitable means, such as by inserting the reduced-memory DIMM into a testing computer system. When power is applied to the testing computer system, firmware initialization begins, along with memory initialization which determines what capacity of DIMM is installed in the testing computer system. Firmware obtains the row, column, and bank information, from which DIMM density MB may be determined. More specifically, firmware will test the addressable space

specified by the information from the DIMM EEPROM. Once

the operating system of the testing computer system is

launched, the addressable memory ranges are passed to the

operating system for use. The unaddressable memory

(i.e., dormant memory) is not available for use.

By the practice of various embodiments of the

present invention, a manufacturer is allowed to

discontinue carrying older, essentially obsolete 64Mb

DRAM technology, particularly when the price/Mb between

the 128Mb DRAM and 64Mb DRAM are approximately the same.

It also allows a manufacturer to continue to sell all the

DIMMs of various densities that is demanded without the

necessity of having to produce and stock numerous DIMM

densities. Thus, the amount of parts for manufacture to

stock in order to build memory is decreased. Additional

practice of various embodiments of the present invention

further allows a manufacturer to memory qualify only one

type of DIMM rather than multiple DIMMs; thus, qualifying

512MB would inherently qualify 256MB. Other possible

embodiments in accordance with the invention includes,

for example, using a 1 gigabyte DIMM with a 256 megabit

DRAM. Other suitable permutations are also permissible

within the scope of embodiments of the invention.

Reference throughout this specification to "one embodiment", "an embodiment", or "a specific embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention and not necessarily in all embodiments. Thus, respective appearances of the phrases "in one embodiment", "in an embodiment", or "in a specific embodiment" in various places throughout this specification are not necessarily referring to the same embodiment. Furthermore, the particular features, structures, or characteristics of any specific embodiment of the present invention may be combined in any suitable manner with one or more other embodiments. It is to be understood that other variations and modifications of the embodiments of the present invention described and illustrated herein are possible in light of the teachings herein and are to be considered as part of the spirit and scope of the present invention.

Further, at least some of the components of an embodiment of the invention may be implemented by using a programmed general purpose digital computer, by using application specific integrated circuits, programmable logic devices, or field programmable gate arrays, or by

using a network of interconnected components and

circuits. Connections may be wired, wireless, by modem,

and the like.

It will also be appreciated that one or more of the

elements depicted in the drawings/figures can also be

implemented in a more separated or integrated manner, or

even removed or rendered as inoperable in certain cases,

as is useful in accordance with a particular application.

It is also within the spirit and scope of the present

invention to implement a program or code that can be

stored in a machine-readable medium to permit a computer

to perform any of the methods described above.

Additionally, any signal arrows in the

drawings/Figures should be considered only as exemplary,

and not limiting, unless otherwise specifically noted.

Furthermore, the term "or" as used herein is generally

intended to mean "and/or" unless otherwise indicated.

Combinations of components or steps will also be

considered as being noted, where terminology is foreseen

as rendering the ability to separate or combine is

unclear.

As used in the description herein and throughout the claims that follow, "a", "an", and "the" includes plural references unless the context clearly dictates otherwise. Also, as used in the description herein and throughout the claims that follow, the meaning of "in" includes "in" and "on" unless the context clearly dictates otherwise.

The foregoing description of illustrated embodiments of the present invention, including what is described in the Abstract, is not intended to be exhaustive or to limit the invention to the precise forms disclosed herein. While specific embodiments of, and examples for, the invention are described herein for illustrative purposes only, various equivalent modifications are possible within the spirit and scope of the present invention, as those skilled in the relevant art will recognize and appreciate. As indicated, these modifications may be made to the present invention in light of the foregoing description of illustrated embodiments of the present invention and are to be included within the spirit and scope of the present invention.

Thus, while the present invention has been described herein with reference to particular embodiments thereof, a latitude of modification, various changes and substitutions are intended in the foregoing disclosures, and it will be appreciated that in some instances some features of embodiments of the invention will be employed without a corresponding use of other features without departing from the scope and spirit of the invention as set forth. Therefore, many modifications may be made to adapt a particular situation or material to the essential scope and spirit of the present invention. It is intended that the invention not be limited to the particular terms used in following claims and/or to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include any and all embodiments and equivalents falling within the scope of the appended claims.